

Having described the invention, the following is claimed:

1. An apparatus for tracking at least one head candidate, said apparatus comprising:
 - an image analyzer for analyzing an image signal to identify at least one of a plurality of possible new head candidates within an area of interest and for providing data related to the identified at least one head candidate;
 - a tracking system that stores location information for at least one tracked head candidate; and
 - a candidate matcher that predicts the current position of a given tracked head candidate, selects a subset of the at least one of the plurality of possible new head candidates according to their distance from the predicted position, and evaluates the similarity of each member of the selected subset to the tracked candidate to determine if a new head candidate within the selected subset represents a current position of the tracked head candidate.
2. The apparatus of claim 1, further comprising an image source that provides the image signal to the image analyzer.
3. The apparatus of claim 2 wherein the image source includes a stereo camera.

4. The apparatus of claim 1 wherein the candidate matcher updates the location information at the tracking system according to the determined matches.

5. The apparatus of claim 1 wherein a confidence value associated with the given tracked candidate is updated at the tracking system according to the evaluation of the candidate matcher.

6. The apparatus of claim 1 wherein the candidate matcher selects a predetermined number of the identified at least one of a plurality of possible new head candidates that are closest to the predicted location.

7. The apparatus of claim 1 wherein the candidate matcher determines at least one threshold distance based on the projected location and selects all of the identified at least one of a plurality of possible new head candidates falling within a selected one of the determined at least one threshold distance.

8. The apparatus of claim 7 wherein a confidence value associated with the given tracked candidate is updated according to the position of the selected subset of the identified at least one of a plurality of possible head candidates relative to the at least one threshold distance and the evaluated similarity of identified at least one of a plurality of possible head candidates to the tracked candidate.

9. The apparatus of claim 1 wherein the candidate matcher matches a given tracked head candidate with one of the selected subset of the identified at least one of a plurality of possible new head candidates according to respective similarity scores associated with the subset of new head candidates, a given similarity score reflecting a degree to which an associated new head candidate resembles the tracked head candidate across at least one feature.

10. The apparatus of claim 9 wherein a given similarity score is calculated by a pattern recognition classifier.

11. The apparatus of claim 1 wherein the image analyzer includes means for performing a head candidate algorithm using the image signal to identify the at least one of the plurality of possible new head candidates in the area of interest.

12. The apparatus of claim 11 wherein the image analyzer further includes means for determining the position of the at least one of the plurality of possible new head candidates.

13. The apparatus of claim 11 wherein the means for performing the head candidate algorithm includes first determining means for determining a blob image from the image signal.

14. The apparatus of claim 13 wherein said means for performing the head candidate algorithm further includes second determining means for determining a contour of the blob image and establishing a contour image in response thereto.

15. The apparatus of claim 14 wherein said means for performing the head candidate algorithm further includes third determining means for determining turning point locations of the contour image.

16. The apparatus of claim 15 wherein said means for performing the head candidate algorithm further includes means for performing an ellipse fitting algorithm for determining the quality of ellipse fits of the contour image between determined turning point locations.

17. The apparatus of claim 11 wherein said means for performing the head candidate algorithm includes means for determining at least one of a 3D spherical shape head candidate, a contour based head candidate, and a motion based head candidate from the image signal.

18. The apparatus of claim 1 further including an air bag and means for controlling the air bag in response to the current position of the at least one tracked head candidate.

19. An air bag restraining system for helping to protect an occupant of a vehicle upon the occurrence of a vehicle crash event, said apparatus comprising:

an air bag restraining device for, when actuated, helping to protect the vehicle occupant;

crash sensor for sensing a vehicle crash event and, when a crash event occurs, providing a crash signal;

an air bag controller for monitoring the crash sensor and controlling actuation of the air bag restraining device;

a stereo vision system for imaging an interior area of the vehicle and providing an image signal of the area of interest;

an image analyzer for analyzing the image signal to identify at least one of a plurality of possible new head candidates within an area of interest and for providing data related to the identified at least one head candidate;

a tracking system that stores location information for at least one tracked head candidate: and

a candidate matcher that predicts the current position of a given tracked head candidate, selects a subset of the identified at least one of a plurality of possible new head candidates according to their distance from the predicted position, evaluates the similarity of each member of the selected subset to the tracked candidate to determine if a new head candidate within the selected subset represents a current position of the tracked head candidate, and provides a signal to the air bag controller

indicating the current position of each of the at least one tracked head candidates;

the air bag controller controlling actuation of the air bag restraining device in response to both the crash signal and the current position of the at least one tracked head candidate.

20. A head candidate matching method for determining a current location of a previous head candidate, the method comprising the steps of:

imaging a class object and providing an image signal of an area of interest;

identifying at least one of a plurality of possible new head candidates and associated location data from the image signal;

predicting the current location of the previous head candidate according to its previous location and motion;

selecting a subset of the identified at least one of the plurality of possible new head candidates based on the distance of each of the identified at least one of the plurality of possible new head candidates from the predicted location; and

comparing each of the selected subset of new head candidates to the previous head candidate across at least one desired feature.

21. The method of claim 20 wherein the step of imaging a class object includes using a stereo camera.

22. The method of claim 20 wherein selecting a subset of the identified at least one of a plurality of possible new head candidates includes selecting a predetermined number of the identified at least one of a plurality of possible new head candidates that are closest to the predicted location.

23. The method of claim 20 wherein selecting a subset of the identified at least one of a plurality of possible new head candidates includes establishing a threshold distance around the predicted location and selecting every new head candidate within the threshold distances.

24. The method of claim 23 wherein selecting a subset of the identified at least one of a plurality of possible new head candidates includes establishing a plurality of threshold distances around the predicted location and selecting every new head candidate within a selected one of the plurality of threshold distances.

25. The method of claim 24, the method further comprising selecting the smallest threshold distance encompassing at least one new head candidate.

26. The method of claim 24, the method further comprising updating a tracking confidence associated with the previous head candidate according to the selected threshold distance.

27. The method of claim 24 the plurality of threshold distances comprising an inner threshold distance and an outer threshold distance and the method further comprising comparing a confidence value associated with a selected new head candidate to a threshold value only if the selected new head candidate falls between the inner threshold distance and the outer threshold distance.

28. The method of claim 20 wherein comparing the selected subset of new head candidates to the previous head candidate includes computing a similarity score for each selected new head candidate based upon its similarity to the previous head candidate and identifying the new head candidate with the best similarity score as the current location of the previous head candidate.

29. The method of claim 28 wherein computing the similarity score for a given new head candidate includes providing feature data associated with the new head candidate and feature data associated with the previous head candidate to a pattern recognition classifier.

30. A method for tracking a previously identified head candidate, comprising:

imaging a class object and providing an image signal of an area of interest;

identifying at least one of a plurality of possible new head candidates and associated location data from the image signal;

predicting the current location of the previous head candidate according to its previous location and motion;

defining at least one threshold distance around the predicted location; and

updating a tracking confidence value associated with the previously identified head candidate according to respective positions of the identified at least one of the plurality of new head candidates relative to the at least one defined threshold distance.

31. The method of claim 30 wherein updating the tracking confidence value includes decreasing the tracking confidence value when no identified new head candidate is encompassed by a selected one of the defined at least one threshold distance.

32. The method of claim 30 wherein updating the tracking confidence value includes the steps of:

selecting a defined threshold distance;

selecting a new head candidate within the selected defined threshold distance; and

adding a value reflecting the similarity of the new head candidate to a human head to the tracking confidence value.

33. The method of claim 32 wherein selecting a defined threshold distance includes selecting the smallest threshold distance encompassing at least one new head candidate.